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Vigo

A NEW DISEASE-RESISTANT WHEAT

Purdue university
AGRICULTURAL EXPERIMENT STATION
Lafayette · Indiana

cooperating with Bureau of Plant Industry, Soils, and Agricultural Engineering, Agricultural Research Administration, U. S. Department of Agriculture, Washington, D. C.

Summary

Vigo, a new soft red winter wheat, was released to certified seed producers in 1946. It was bred by the combined efforts of the Purdue University Agricultural Experiment Station and the U. S. Department of Agriculture. Vigo was produced from a cross of the loose smut-resistant variety Trumbull with a leaf rust-resistant strain, Fultz selection C.I. 11512. Both parents possess high quality grain characteristics.

The merits of Vigo wheat include moderate resistance to leaf rust and resistance to loose smut and mosaic diseases, superior bushel weight of grain and high yield. It is a medium season, beardless, white chaff variety having strong straw. It possesses a dark green foilage in both the seedling and headed stages.

Vigo has shown winter hardiness superior to that of most good quality soft red winter wheats and about equal to that of Fairfield, both at Lafayette and in interstate tests.

The yield of Vigo has been superior to standard varieties under severe rust attack and approximately equal to the better varieties where rust was not a factor. The new variety has shown superior yielding ability in a number of states cooperating in a uniform yield test experiment.

The milling and baking quality of Vigo wheat has been found to equal or exceed that of the soft red varieties now considered as standards by the soft wheat milling and baking trades.

Although Vigo is resistant to common races of leaf rust and loose smut, there are races of these organisms known which may attack this variety and these may increase sufficiently to cause damage in Indiana. Breeding for resistance to these destructive races is in progress.

Vigo—A New Disease Resistant Wheat

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The leaf rust of wheat has been widely recognized as the most destructive disease of soft winter wheat and one of the greatest hazards in the production of that crop. The Purdue University Agricultural Experiment Station in cooperation with the U. S. Department of Agriculture has long been working to find resistance to the leaf rust and to breed that resistance into desirable soft red winter varieties. Vigo wheat, bred for resistance to the leaf rust, loose smut, and mosaic diseases, is the first new wheat variety to come from these efforts. It has been grown in experimental plots under the number C.I. 12220.[1] It was released to certified seed growers in 1946.

The Breeding of Vigo Wheat

Vigo wheat was originated at the Purdue University Agricultural Experiment Station within a breeding project conducted cooperatively with the U. S. Department of Agriculture. It was selected in 1937 from a bulk F_6 population of a cross made by the writers in 1932 between the variety Trumbull C.I. 5657 and Fultz selection C.I. 11512.

The Trumbull parent, which originated at the Ohio Experiment Station, has been for many years one of the most extensively grown soft red winter wheats. It is a standard of grain milling and baking quality and possesses straw of good strength, yields well and is highly resistant to the loose smut disease.

The parent, Fultz selection C.I. 11512, is a leaf rust-resistant strain of the Fultz variety. It was selected by E. B. Mains of the Purdue University Agricultural Experiment Station and the U. S. Department of Agriculture from Fultz C.I. 5308 which was found to be segregating for leaf rust resistance. It was the source from which both C.I. 11512 and its sister selection, Wabash C.I. 11384, originated. The C.I. 11512, in addition to leaf rust resistance, possesses superior winter hardiness, high yielding ability and excellent grain, milling and baking quality. Vigo combines in a large measure the desirable qualities of each parent.

Origin of the Name Vigo

Vigo wheat has been named in honor of Vigo County, Indiana and the famed frontiersman, trader, and soldier, Francisco Vigo, who in 1779 contributed much to the winning of the military triumphs of the George Rogers Clark expedition in territory that is now in the heart of the soft red wheat producing area.

[1] C.I. refers to the accession numbers of the Division of Cereal Crops and Diseases, Bureau of Plant Industry, Soils and Agricultural Engineering, U. S. Department of Agriculture.

Description

Vigo is a beardless, white-chaffed, soft red winter wheat variety. The apical florets bear short awnlets. The heads are large and decidedly nodding when dead ripe (figure 1). The plant height has been slightly greater than Trumbull and Fairfield at Lafayette in Northern Indiana but about equal to these varieties in the southern part of the state (table 1) and in the interstate tests (table 2). The straw is erect and has shown superior resistance to lodging when rank growth occurred under conditions of high moisture and soil nitrogen (see cover illustration). Vigo is of medium season maturity, being similar to Trumbull and Fairfield and is slightly earlier than Thorne and Purkof in most tests of the cooperative interstate trials (table 2). The foliage color is a distinctive deep green as compared with that of most soft wheat varieties.

Table 1. Characteristics of Vigo wheat compared with those of standard varieties. 1941-1946.

	Plant height				Bushel weight Lafayette, Ind.	Wt. per 1000 kernels Lafayette, Ind.
	Lafayette Indiana Av. 1945-1946	Sullivan Indiana 1945	Washington Indiana 1945	Evansville Indiana 1945	Rod row plots Av. 1941-1946	Rod row plot Av. 1945-1946
	In.	In.	In.	In.	lbs.	gm.
Vigo	52	50	49	56	59.6	33.4
Fairfield	48	49	50	58	57.0	34.2
Thorne	....	47	45	54	....	....
Trumbull	48	....	....	....	59.0	35.2
Michigan Amber	51	....	....	....	58.9	31.6

Yielding Ability

Yield tests of Vigo in comparison with standard varieties have been conducted at Lafayette, Indiana over the period 1941 to 1946 in both replicated rod rows and 1/48th acre field plots. In the rod rows the varieties have been exposed to severe leaf rust epidemics by inoculating susceptible varieties grown in the paths between plots from which the rust had equal opportunity to spread to each of the varieties under test. Under these conditions Vigo produced an average yield of 37.9 bushels per acre as compared with 31.2, 34.1 and 31.9 bushels for Trumbull, Fairfield and Michigan Amber (table 3). In the field plots[2], where leaf rust, though present, was not severe during the test years, the yield of Vigo approximately equalled that of the standard varieties Gladden, Fairfield and Thorne.

Yield tests of Vigo and standard older varieties were conducted in drill-width field plots at three locations in southwestern Indiana in 1945.[3] Here Vigo outyielded Fultz, Rudy and Goens from 4.0 to 3.3 bushels on the average and approximately equalled the yields of Fairfield and Thorne.

In the 46 uniform interstate tests conducted in 12 states in 1943, 1944 and 1946, Vigo has shown superior yielding ability over a wide geographical range (table 2). Its average yield in these tests exceeded that of the varieties Trumbull, Purkof, Thorne and Fairfield.

[2] Tests were conducted by R. R. Mulvey, Department of Agronomy.
[3] Tests were conducted by E. C. Skiver of the Department of Agronomy.

Figure 1. Heads and kernels of Vigo wheat.

Winter Hardiness

Vigo has shown superior winter hardiness in those years when winter conditions have been severe enough to cause differential killing of wheats of differing degrees of hardiness. In 1943 the hardiness of Vigo was shown in 7 states extending from Nebraska to West Virginia. The survival of Vigo and 4 commonly grown wheats are reported in table 4. The results at Lafayette were similar to those obtained at Madison, Wisconsin; Lincoln, Nebraska; Lathrop, Missouri. At those three locations, winter injury was also caused by low temperatures. Vigo was similar in winter survival to Fairfield and Purkof at these stations. All three were much superior to Thorne and Trumbull in resistance to cold.

In the tests at Germantown, Ohio and Morgantown, West Virginia, the wheats were injured by conditions other than low temperatures. In these two tests the survival of Vigo was again superior to Thorne and Trumbull indicating a significant degree of resistance to one or more causes of winter injury other than cold. Heaving caused by freezing and thawing was presumably one of the causes of the injury at these stations.

Table 2. Performance of Vigo and older winter wheat varieties grown in the interstate cooperative soft winter wheat test in 1943, 1944 and 1946.[1]

	Acre yield[2]				Plant height[3]				Bushel weight[4]			Average date headed[5]			Leaf rust infection[6]	
	1943	1944	1946	Annual average	1943	1944	1946	Annual average	1943	1944	1946	1943	1944	1946	1943	1944
	Bu.	Bu.	Bu.		In.	In.	In.	In.				June	May	May	Per Cent	Per Cent
Vigo	26.3	30.6	33.7	30.2	39	45	47	43.7	55.1	58.2	58.7	5	29	27	17	5
Trumbull	23.0	28.6	30.3	27.3	39	43	40	40.7	53.5	57.7	58.4	6	30	26	70	65
Purkof	26.2	28.5	32.0	28.9	40	45	47	44.0	55.7	58.2	58.7	6	30	28	37	41
Thorne	22.8	32.6	32.0	29.1	38	44	45	42.3	52.5	56.6	57.3	6	29	27	66	56
Fairfield	24.1	30.1	33.1	29.1	39	45	45	43.0	53.5	57.3	57.2	6	28	26	58	53

[1] These tests were conducted by cooperating state and federal workers in one or more plantings in each of the following states: Missouri, Illinois, Wisconsin, Michigan, Indiana, Kentucky, Ohio, New York, Pennsylvania, West Virginia, Maryland, North Carolina.

[2] Yield data from 15 stations in 1943; 15 stations in 1944; 16 stations in 1946.

[3] Plant height data from 7 stations in 1943; 8 stations in 1944; 9 stations in 1946.

[4] Bushel weight data from 3 stations in 1943; 7 stations in 1944.

[5] Date headed data from 7 stations in 1943; 8 stations in 1944; 8 stations in 1946.

[6] Leaf rust data from 4 stations in 1943; 9 stations in 1944.

A critical test of resistance to low-temperature injury in Vigo was secured at Lafayette in 1942 in the rod-row yield nursery. The survival was as follows in this test:

Vigo	75 per cent
Fairfield	70 per cent
Purkof	85 per cent
Thorne	34 per cent
Trumbull	65 per cent

Another indication of the hardiness of Vigo wheat in the same year is to be found in the yield records of 1942 (table 3). In these tests Vigo, Fairfield, and Michigan Amber survived the winter with considerably better stands than did Thorne and Trumbull. The stand differences are reflected in much greater yields of the more hardy varieties.

Table 3. Yields of Vigo wheat compared with those of standard varieties. Lafayette, Indiana 1941-1946.

	Yield in bushels per acre												
	Field plot trials[1]						Rod-row trials (leaf rust infected)[2]						
	1942	1943	1944	1945	1946	Av.	1941	1942	1943	1944	1945	1946	Av.
Vigo	18.7	27.9	31.6	37.3	44.2	31.9	48.2	23.2	32.6	37.6	39.2	46.6	37.9
Gladden	10.9	27.6	31.9	39.5	42.9	30.6	...		..	.	...	..	...
Fairfield	19.7	28.4	31.5	38.5	43.1	32.2	40.0	18.8	33.4	31.5	36.0	44.8	34.1
Thorne	9.9	27.6	31.9	39.4	45.4	30.8	....		..	.	...	...	...
Trumbull	....	..	.	..	..	..	40.2	12.0	28.9	29.7	34.4	41.9	31.2
Michigan Amber	...	..	...	..	..	..	36.8	22.0	26.0	28.2	40.0	38.5	31.9

[1] 1/48 acre plots were used during 1942-1945 and 1/40 acre plots in 1946, each variety replicated 4 times.

[2] Rod-row trials were replicated 5 times.

Grain Quality

The kernel of Vigo is of average size (table 1), and of a relatively short thick shape. The exterior is uniform and smooth in outline (figure 1). The interior texture is uniformly mealy. In bushel weight of grain, Vigo has consistently exceeded the standard varieties—Fairfield, Trumbull and Michigan Amber. Its average test weight at Lafayette for the period 1941-1946 was 59.6 pounds per bushel. A similar test weight record was made in the interstate test in 1943 and 1944 (table 2).

The milling and baking quality of Vigo grain has been shown to equal or excell that of the standard commercial soft wheat varieties. The results of the "doughball" and "pearling" tests reported in tables 5 and 6 indicate a quality similar to that of Trumbull. More extensive tests by the Federal Soft Wheat Laboratory[4] at Wooster, Ohio corroborate these findings. Milling and baking tests by a large commercial baking firm indicate that grain quality factors of Vigo meet the requirements of the soft wheat products baking trade (figure 2).

[4] Studies made by Dr. Vincent Morris.

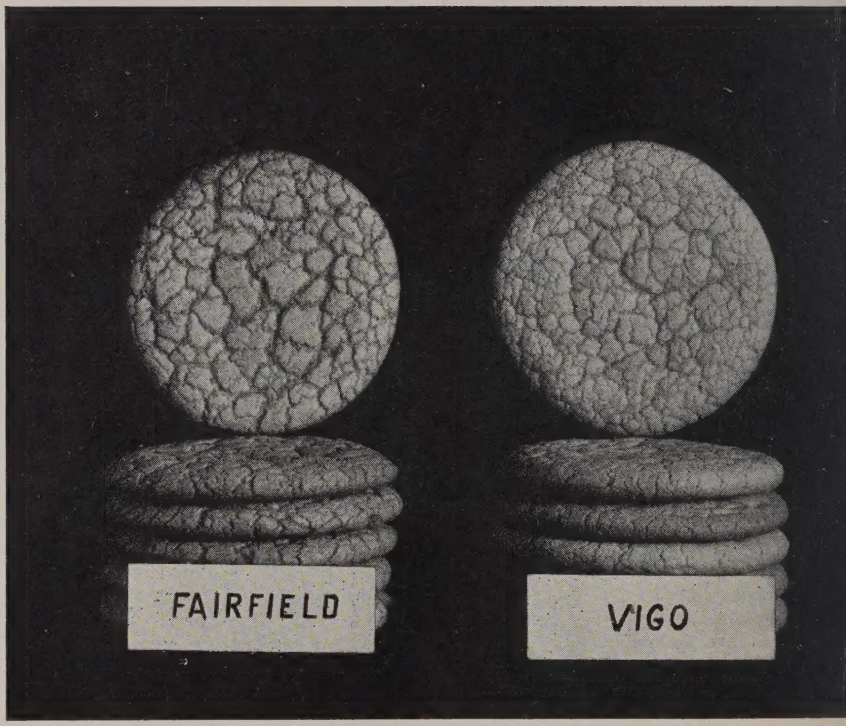

Figure 2. Flour of Vigo (C.I. 12220) produced a superior product in cookie baking tests made by a commercial baking company.

Leaf Rust Resistance

Vigo possesses a valuable degree of resistance to leaf rust in the field. It is highly resistant to most races of leaf rust but has shown moderate susceptibility to race 76 of this rust. Results of severe tests of resistance to leaf rust in the period 1941 to 1946 are reported in table 7. During the first 4 and last years, Vigo was only lightly attacked but in 1945 more severe infection took place, although it was lighter and occurred later than on susceptible varieties. In the interstate tests of 1943 and 1944 the average leaf rust infection of Vigo was 11 per cent as compared with 55, 66 and 63 per cent for Fairfield, Thorne and Trumbull respectively (table 2).

Table 4. Winter survival of Vigo compared with those of standard varieties in the cooperative interstate test. 1943.[1]

Variety	Per cent survival at					
	Lincoln, Nebr.	Madison, Wis.	Lathrop, Mo.	Lafayette, Ind.	Germantown, Ohio	Morgantown, W. Va.
Vigo	80	91	15	70	72	81
Fairfield	77	95	10	70	78	55
Purkof	85	97	10	75	77	49
Thorne	62	53	0	40	15	41
Trumbull	52	59	10	40	7	60

[1] These data provided by cooperating state and federal plant scientists.

Table 5. Gluten strength of Vigo and other standard soft wheats as measured by the "dough ball time test."

Variety	Doughball time in minutes							
	1940	1941	1942	1943	1944	1945	1946	Average
Vigo	44	37	48	50	46	29	36	41.0
Trumbull	68	43	62	47	53	32	39	46.0
Fairfield	72	61	78	79	58	46	51	62.2
Michigan Amber	65	65	83	68	62	80	77	72.5

Table 6. Kernel hardness of Vigo and other standard soft wheats as measured by the "pearling index."

Variety	Per cent pearled off							
	1940	1941	1942	1943	1944	1945	1946	Average
Vigo	50	49	49	37	34	35	40	42
Trumbull	47	44	45	52	33	34	32	41
Fairfield	....	50	49	50	35	37	37	43
Michigan Amber	34	32	38	38	26	25	28	32

Loose Smut Resistance

Vigo has inherited resistance to loose or "black" smut from its Trumbull parent. Trumbull has long been known for its almost complete freedom from loose smut in Indiana. Tests of both Trumbull and Vigo to numerous races of loose smut collected in Ohio, Indiana and Illinois have indicated high resistance to the loose smut found in these areas. The occurrence of loose smut from severe natural exposure to infection in Vigo and other soft wheats, grown together under comparable conditions at Lafayette, is reported in table 8. Vigo, Trumbull and Fairfield displayed high resistance in comparison with high susceptibility of Michigan Amber.

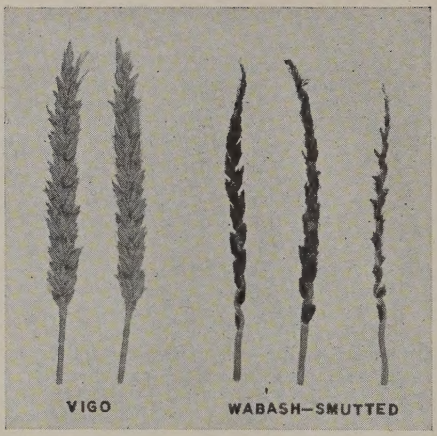

Figure 3. Photograph of loose smut infested heads of the Wabash variety (right) and normal heads of the resistant Vigo (left).

Resistance to the Wheat Mosaic Disease

Vigo is highly resistant to the wheat mosaic disease. This disease causes from severe-to-moderate stunting of susceptible varieties such as Clarkan, Purkof and Blackhawk and may result in death of the plants most severely stunted (figure 4). Yield losses are severe in varieties such as Purkof, Purdue No. 1 and Red Cross or Harvest Queen now grown in Indiana. This disease is caused by a virus that is carried in the soil and is widely distributed in the Indiana soft wheat area. The only control is through the use of resistant soft wheat varieties. Many varieties that have originated in other areas where the mosaic disease does not occur are susceptible and should not be grown in Indiana.

Table 7. Leaf rust infection of Vigo wheat compared with that of standard varieties. Lafayette, Indiana. 1941-1946.

Variety	Percentage leaf rust severity						
	1941	1942	1943	1944	1945	1946	Average
Vigo	10	13	20	20	75	15	25.5
Trumbull	85	90	65	93	95	100	88.0
Fairfield	85	90	83	93	95	75	86.8
Michigan Amber	75	50	63	85	80	90	73.8

Table 8. Loose smut infection of Vigo wheat compared with that of standard varieties.

Variety	Loose smut heads per rod row						
	1941	1942	1943	1944	1945	1946	Average
Vigo	0.0	0.0	0.0	0.0	1.0	0.0	0.2
Trumbull	0.5	0.5	0.0	0.0	2.0	0.2	0.5
Fairfield	2.0	0.0	2.5	0.0	0.5	0.4	0.9
Michigan Amber	61.5	25.0	30.0	19.0	13.0	3.4	25.3

Menace of New Races of Wheat Disease Organisms

Whenever disease-resistant varieties are widely grown, new races of the disease-producing rusts, smuts or other organisms may appear, which have the ability to attack the hitherto resistant varieties. Race 76 of leaf rust has caused some damage to Vigo in certain locations and may be expected to reappear in some locations although it has not as yet been widespread on this variety in the interstate tests. Races of loose smut attacking to some extent the parent variety, Trumbull, are also known in the southern and southeastern states. They have not yet appeared in the more northern soft wheat growing states but would attack Vigo with at least moderate severity if they were introduced there.

Resistance to these races of leaf rust and loose smut has been found in certain varieties. Breeding work is in progress to transfer such resistance to wheat varieties adapted for the soft wheat area and having the necessary milling and baking requirements.

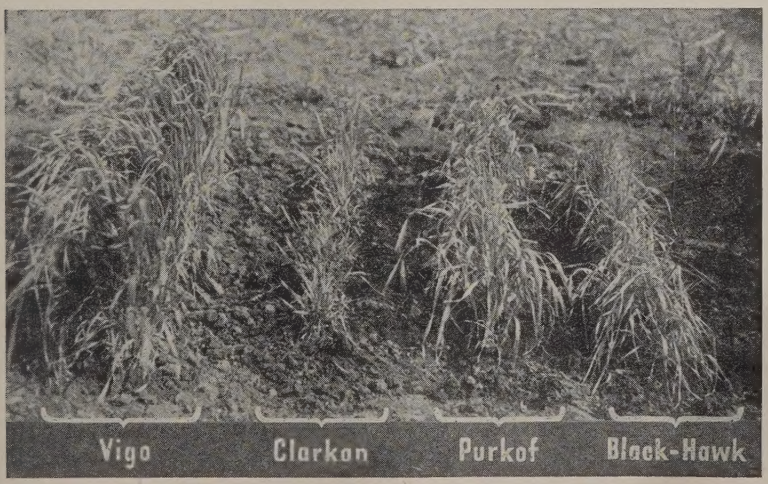

Figure 4. Photograph of the mosaic resistant Vigo growing beside susceptible varieties on land infested with the wheat-mosaic virus. Note the vigorous growth of Vigo, the extreme stunting of Clarkan and the lesser but severe stunting of Purkof and Blackhawk.